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EFFECT OF NITROGEN, NICKEL AND AZOSPIRILLUM ON NUTRIENT CONTENT AND UPTAKE BY GRAIN AND NUE OF WHEAT UNDER TYPIC USTOCHREPTS SOIL

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ABSTRACT

The pot experiment was conducted at the Micronutrient Research Project (ICAR) experimental site, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) during rab iseason of the year 2012-2013. The experiment was laid out in a Factorial Completely Randomized Design (FCRD), comprising sixteen treatment combinations of four levels of N (120 RDN, 120, 100 and 80 kg N ha^{-1} in four equal splits), two levels of Ni (0 and 5 mg Ni kg^{-1}) and two levels of bio-fertilizer (seed inoculation with and without Azospirillum) which were replicated three times. The significantly higher nitrogen content in grain and uptake of nitrogen by grain were obtained under to 120 kg N ha^{-1} with four splits at basal, 30, 45 and 60 DAS than control (N_1) and N_4 treatments, but it was at par with 100 kg N ha^{-1} with similar split applications. The significantly highest nitrogen content and uptake and nickel content and uptake by wheat grain was received due to 5 mg Ni kg^{-1} and seed inoculation with bio-fertilizer (Azospirillum). with the increase in split application of N AE and ANR were found increased ever with the reduced level of N application. Highest PE was noticed under 80 Kg N ha^{-1} with 4 splits but yield was significantly lower than 100 Kg N ha$^{-1.}$Nickel and seed inoculation with Azospirillum influenced NUE.

KEYWORDS: Nitrogen, Nickel, Azospirillum, Nitrogen, Nickel Content and Uptake, Agronomy Efficiency, Physiological Efficiency, Apparent Nitrogen Recovery

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INTRODUCTION

Nitrogen is one of the most important primary nutrient among non-metal elements which requires in large quantity for the plant growth and nutrition. It is the most widely distributed element in nature. It occurs in atmosphere, lithosphere and hydrosphere. The soil accounts for very small amount of lithospheric nitrogen and of this soil nitrogen, a very minute amount is directly available to plants. Nitrogen occurs in soils mainly in the form of nitrate (NO_3^-) and ammonium (NH_4^+) ions. Nitrogen is known to be a very mobile element circulated between the atmosphere, the soil and living organisms. The objective of N management is to maximize the use efficiency of applied N by plant. An increase in efficiency will increase the agronomic value of the fertilizer by increasing crop production, conserve energy by saving on the raw material used to make the N and minimize the potential for adverse effect on the environment. Nitrogen use efficiency is defined as the ratio of the crop nitrogen uptake, to the total input of nitrogen fertilizer. It can also be defined more broadly as the ratio, of crop nitrogen uptake, to available soil N which would include applied fertilizer N plus residual mineral N in the soil. The greater the ratio the better the nitrogen use efficiency. Producers and agronomists strive to optimize crop yields with minimum

nitrogen inputs.

Nickel plays role in the cycling of nitrogen stored in seeds as protein-bound guanidines of free arginine, purines, or ureides. Nickel regulates the mineral metabolism, enzyme activity and several other metabolic processes in plants. Apart from urease, nickel is also essential for the functions of several other enzymes like hydrogenase and methyl reductase. It is also needed for grain filling, seed viability, iron absorption and urea and ureide metabolism. It is a well-known phenomenon that low concentrations of Ni are necessary in N-metabolism and the germination of plants, such as cereals and cowpeas (Krogemeier *et al.* 1991, Gerendas *et al.* 1999). Nickel may also be required for symbiotic nitrogen fixation by legumes (Gerendas and Sattelmacher 1997). It also influences nitrogen uptake and transport in plants. Milosevic *et al.* (2002) studied the effects of Ni application as $NiCl_2$ at 0, 0.02, 2 and 200 mg Ni kg^{-1} soil on 21-day-old wheat plants. The plants and soil were sampled after 14 days of treatment and were analysed to evaluate the effect of Ni on plant growth, chlorophyll content, respiration and transpiration intensity, on the numbers of some soil microorganisms (aerobic heterotrophic, ammonifying, aerobic free-living N_2-fixing bacteria and separately, Azotobacter cells, as well as actinomycetes and micromycetes) and on soil dehydrogenase, protease, endoglucanase, cellobiohydrolase and beta -glucosidase activities. They reported that plant growth was stimulated by low rate of Ni and inhibited by high Ni rate. The chlorophyll content decreased while intensity of respiration increased at each Ni rate. The Ni strongly reduced the numbers of soil microorganisms, except the number of Azotobacter cells, which increased significantly at low Ni rate. The enzyme activities were very sensitively affected by the medium and high Ni rates.

Azospirillum is a Gram negative, motile and produces beta hydroxyl granules. Since 1970's, *Azospirillum* strains have been isolated and used. Members of the genus *Azospirillum* fix nitrogen under microaerophilic conditions and are frequently associated with root and rhizosphere of a large number of agriculturally important crops and cereals. It increases the yield is mainly attributed to improved root development due to the production of growth promoting substances and consequently increased rates of water and mineral uptake.

MATERIALS AND METHODS

The pot experiment was conducted at the Micronutrient Research Project (ICAR) experimental site, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) during *rabi* season of the year 2012-2013. Geographically, Anand is situated at 22^0 35' N latitude, 72^0 55' E longitudes with an elevation of 45.1 m above the mean sea level. The climate of this region is semi arid and sub tropical. This experiment was containing sixteen treatments comprising different combination of nitrogen, nickel and bio-fertilizer were replicated three times. These treatments include 4 levels of nitrogen, 2 levels of nickel and 2 levels of bio-fertilizer. Urea (46% N) was used as a nitrogen source, potassium di-hydrogen phosphate (22.8% P) was used as phosphorus and nickel was applied through nickel chloride (24.8% Ni),bio fertilizer (*Azospirillum*) was supplied by Bio- fertilizer Project, AAU, Anand. Nitrogen @ 25 % was given as basal and remaining 75 % was given at 30, 45 and 60 days after sowing. The initial soil samples (0-15 cm) had average pH 7.85,Oraganic carbon 0.35%, N 206.5 Kg ha^{-1}, available P_2O_5 29.95 Kg ha^{-1}, K_2O 226Kg ha^{-1},Ni 0.88 mg kg^{-1}.Ten Wheat seeds of GW-496 variety seeds were dibbled in pots and six plants were retained after germination. Four types of fertilizers were used in this investigation programme. The plant samples were washed with dilute 0.01 N HCl, single and double deionized water in a sequence and air dried. These samples were ground using a stainless steel mixer to avoid contamination of micronutrients. Soil analyzed for pH (Jackson 1973), Organic carbon (Walkley and Black 1934), available N (Subbiah and Asija (1956), P (Olsen *et al.* (1954), K (Jackson (1973), Micronutrient Ni (Lindsay and Norvell

(1978) and Dried plant samples (leaf, straw and grain) were digested in di-acid mixture (HNO_3: $HClO_4$ – 4:1) and volume was made with double distilled water (Jackson, 1979). The extract was filtered through Whatman filter paper No. 42. The digested extract of plant samples were used for analysis of micronutrients on atomic absorption spectrophotometer (AAS Model: PE 3110).

Effect of N, Ni and Bio-fertilizer on nutrient content and uptake by grain

Table 1: Effect of N, Ni and Bio-Fertilizer Application on Nutrient Content and Uptake by Grain

Treatment	N Content (%)	Ni content (MG KG^{-1})	N Uptake (G POT^{-1})	Ni Uptake (G POT^{-1})
Nitrogen levels (kg ha^{-1}) (N)				
N_1- 120 RDN (3 splits)	1.76	8.74	0.056	0.028
N_2- 120 (4 equal splits)	1.81	8.79	0.066	0.032
N_3- 100 (4 equal splits)	1.77	8.82	0.063	0.031
N_4- 80 (4 equal splits)	1.72	8.89	0.058	0.030
S. Em. $\pm$	0.01	0.20	0.001	0.001
C.D. (P=0.05)	0.04	NS	0.003	0.003
Nickel levels (mg kg^{-1}) (Ni)				
Ni_0- Control	1.68	8.41	0.057	0.028
Ni_2- 5 mg Ni kg^{-1}	1.85	9.20	0.065	0.033
S. Em. $\pm$	0.01	0.14	0.001	0.001
C.D. (P=0.05)	0.03	0.41	0.002	0.002
Bio-fertilizer inoculation (B)				
B_0- Control	1.75	8.70	0.059	0.029
B_{10}- 10 ml *Azospirillum* kg^{-1} seed	1.78	8.92	0.063	0.031
S. Em. $\pm$	0.01	0.14	0.001	0.001
C.D. (P=0.05)	0.03	NS	0.002	0.002
Interaction				
N x Ni	NS	NS	NS	NS
N x B	NS	NS	NS	NS
B x Ni	NS	NS	NS	NS
N x Ni x B	NS	NS	NS	NS
C.V. %	2.9	7.9	7.38	9.39

Effect of Nitrogen

The Data presented in Table 1 revealed that the application of N altered nitrogen content and uptake and nickel uptake by wheat grain significantly. The significantly higher nitrogen content in grain and uptake of nitrogen by grain were obtained under to 120 kg N ha^{-1} with four splits at basal, 30, 45 and 60 DAS than control (N_1) and N_4 treatments, but it was at par with 100 kg N ha^{-1} with similar split applications. This might be due to prolonged N application where in N helps for synthesis of amino acids, carbohydrates metabolism, protein synthesis and chlorophyll synthesis. The significantly higher uptake of nickel by grain were obtained under to 120 kg N ha^{-1} with four splits at basal, 30, 45 and 60 DAS than control (N_1), but it was at par with 100 kg N ha^{-1}and 80 kg N ha^{-1} with similar split applications. The results are in line with those reported by Singh *et al.* (2011) and Tabatabai (2009).

Effect of Nickel

The Data presented in Table 1 revealed that the application of Ni altered nitrogen content and uptake and nickel content and uptake by wheat grain significantly. The significantly highest nitrogen content and uptake and nickel content and uptake by wheat grain was received due to 5 mg Ni kg^{-1}. Similar results were also reported by Tabatabai (2009).

Effect of Bio-Fertilizer

The data presented in Table 1 revealed that seed inoculation with Bio-fertilizer altered nitrogen content and uptake and nickel uptake by grain significantly. The significantly highest nitrogen content and uptake and nickel uptake by grain of wheat were recorded due to seed inoculation with bio-fertilizer. *Azospirillum* inoculation helps the plants by fixing atmospheric N more effectively. As a result, the N content in seeds may increased. The result confirms the findings of Sharma *et al.* (2013) and Nadeem *et al.* (2004).

NITROGEN USE EFFICIENCY

Table 2: Nitrogen use Efficiency

Treatment	Agronomy Efficiency (Kg ha^{-1})	Physiological Efficiency (Kg ha^{-1})	Apparent Nitrogen Recovery (%)
Nitrogen levels (kg ha^{-1}) (N)			
N_2- 120 (4 equal splits)	1.31	45.58	2.87
N_3- 100 (4 equal splits)	1.31	52.69	2.48
N_4- 80 (4 equal splits)	0.84	91.86	0.91
Nickel levels (mg kg^{-1}) (Ni)			
Ni_2- 5 mg Ni kg^{-1}	-	18.34	-
Bi_o-fertilizer inoculation (B)			
B_{10}- 10 ml *Azospirillum* kg^{-1} seed	-	46.24	-

To evaluate the effect of prolonged N application impact of Ni and Bio-fertilizer application on N use efficiency, the AE, PE and ANR were calculated and present in table 2.The data revealed that with the increase in split application of N AE and ANR were found increased ever with the reduced level of N application. Similar results was also reported by stalin *et al.* (2008). Futher, the physiological efficiency of N was higher (52.7) in case of N @ 100 Kg ha^{-1} in four splits as compared with 120 Kg N ha^{-1} in 4 splits. Highest PE was noticed under 80 Kg N ha^{-1} with 4 splits but yield was significantly lower than 100 Kg N ha^{-1}. Thus, 100 Kg N ha^{-1} in 4 splits found better to increase N utilization of applied N. Application of Ni and Bio-fertilizer were also found to increase N use efficiency table 2

CONCLUSIONS

The Nitrogen, nickel content and uptake by grain was optimum at 100 Kg N ha^{-1} with 4 splits in presence of 5 mg Ni kg^{-1} and seed inoculation with *Azospirillum*. The application 100 Kg N ha^{-1} in 4 splits, 5 mg Ni kg^{-1} and seed inoculation with *Azospirillum* found better to increase NUE.

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